USDA
Human Nutrition Research Center

at Tufts University

tion of food intake. He also worked on the mechanisms of the development of diabetes and the metabolism of fat and cholesterol. Mayer has advised three U.S. presidents, the U.S. Congress, the United Nations' Food and Agriculture Organization and World Health Organization, and the United Nations Children's Fund (UNICEF). In 1969, he organized and chaired the first White House Conference on Food, Nutrition and Health. He later served as chairman of the nutrition division of the White House Conference on Aging, and as vice chairman and acting chairman of the Presidential Commission on World Hunger. From 1979 to the present he has been an advisor on food, nutrition and health to the U.S. Secretary of State. One of Mayer's first acts on becoming president of Tufts University was to explore the possibility of establishing a Department of Agriculture laboratory on Nutrition and Aging. Under his leadership, the university has also become the home of the nation's only school of nutrition.

Cover photo by
Richard S. Mandelkorn.

Photos throughout text by
James Higgins
and Edward Jacoby.

Illustrations by Gordon Nealy.

Director, U.S.D.A.
Human Nutrition Research Center on Aging

Irwin H. Rosenberg, M.D. (Harvard University), became the director of the Human Nutrition Research Center on Aging in October 1986. He is professor of nutrition, physiology and medicine at Tufts University. A past president of the American Society for Clinical Nutrition, he currently serves as chairman to the U.S./Japan Malnutrition Panel of the National Institutes of Health (NIH) and is a member of the Public Affairs Committee of the American Institute of Nutrition, the American Society for Clinical Nutrition and the National Digestive Diseases Advisory Board. Formerly on the faculty of Harvard Medical School and the University of Chicago, Dr. Rosenberg was chief of the section of Gastroenterology and the director of the Clinical Nutrition Research Center at the University of Chicago.

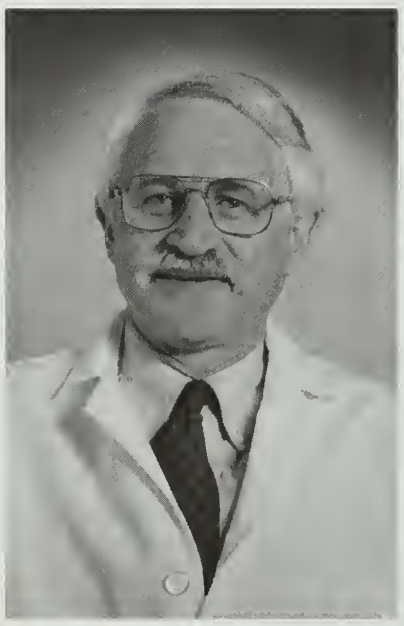
Tufts University is proud to be the home of the Human Nutrition Research Center on Aging. The Tufts Center and its four counterparts are part of an internationally recognized, long-term enterprise of the U.S. Department of Agriculture: research into the food and nutrient requirements of healthy human beings throughout the life cycle. Since the late years of the nineteenth century, before nutrition was recognized as a separate area of scientific interest, the laboratories of the department or those supported by USDA have produced classics of human nutrition research, from the studies of W. O. Atwater on the calories, fat, and protein in foods and E. V. McCollum on the water- and fat-soluble vitamins to those of Walter Mertz on trace minerals.

In creating centers dedicated to a research mission, the USDA has recognized the need for an effort that may be measured in decades rather than a few short years. They have also recognized the need to bring a number of scientific disciplines to bear on the search for answers. The goal is always a better diet for Americans and a better understanding of the role of food and nutrition in a healthy life.

At Tufts, the close physical relationship of the center, dedicated to nutrition research, to the university's health sciences schools and teaching hospitals makes possible the dissemination of research results to health scientists in other disciplines and to clinicians. The center's close intellectual relationship to Tufts' School of Nutrition—the only one in the nation—makes possible the education of a new generation of fine nutritionists through appointments of Center scientists in the school and the participation of students, under their guidance, in research at the center. These linkages, we believe, will provide nutrition research with the permanent home that has been lacking in the United States as interest in nutrition has waxed and waned in a number of universities.

Tufts and the Department of Agriculture have worked together to make the center the successful reality we are celebrating. However, if it were not for the vision and unswerving commitment of the Congress of the United States, and in particular of Senators Hubert Humphrey, Edward Kennedy, Henry Bellmon, and Thomas Eagleton, and Representatives Jamie Whitten, Thomas P. O'Neill, Silvio Conte, and Joseph Moakley, we would never have had the opportunity to provide the people of the United States with new evidence from the center's scientists defining ever more clearly the role of nutrition in healthy aging.

Jean Mayer
President, Tufts University



In the two decades since the White House Conference on Nutrition and Health in 1969 and that on Aging in 1971, there has been a gratifying increase in public concern with the importance of diet, nutrition, and their relationship with health and disease. Nowhere is the promise that improved diet and nutrition may contribute to greater health and vitality more compelling than in the case of the growing population of elderly in this country.

While average life expectancy continues to increase as a substantial credit to our progress in health care and nutrition, we cannot lose sight of the fact that 80 percent of these elderly have at least one chronic condition, of which osteoporosis, arthritis, hypertension, hearing and visual impairments, and cardiac conditions are among the most prevalent. On the average, individuals over the age of seventy-five make eight visits to their doctors every year, and in 1985, approximately five million elderly in the United States required long-term care. That latter number is rising. Thus, one of the great challenges to health science is to examine what it is that we have done successfully to contribute to the steady improvement in life expectancy. We need a broader scientific foundation to make recommendations about diet and nutritional requirements of elderly Americans, and to determine what may be the optimal diets and nutritional intakes throughout life that will allow the greatest number to remain vigorous and self-sufficient in their older years.

Scientists and staff at the USDA Human Nutrition Research Center on Aging at Tufts University face this most important and stimulating challenge. We feel fortunate to be able to work at this uniquely designed and equipped human nutrition research center which has the facilities to examine these important questions. Scientists representing disciplines ranging from molecular biology to epidemiology are examining the function of the many organ systems that change during maturation. Few places in the world have this critical mass of scientists committed to human nutrition research in the setting of a vigorous health sciences campus, part of one of the world's academic centers.

We strongly feel the responsibility to make use of these outstanding resources and our geographical location to bring basic biology and human nutrition together in our effort to provide the foundation for an increasingly healthy and vigorous population of all ages.

Irwin H. Rosenberg, M.D.
Center Director

The Agricultural Research Service (ARS) of the U.S. Department of Agriculture has made a major commitment to human nutrition research in recent years. The USDA Human Nutrition Research Center on Aging at Tufts University (HNRCA) is one of five national human nutrition research centers supported by the ARS. The other centers have the following responsibilities:

Beltsville, MD — develops dietary strategies to delay onset of nutrition-related conditions. Determines nutrient composition and nutritional qualities of food, and defines energy metabolism.

Houston, TX — determines nutrient needs of pregnant and lactating women as well as children.

San Francisco, CA — develops methods for evaluating nutritional status and investigates factors that lead to malnutrition.

Grand Forks, ND — defines human requirements for trace elements and physiological factors that influence them.

The ARS recognizes that a greater understanding of the influence of nutrition on the aging process is required for maintenance of health and quality of life in our aging population. The ARS has made major commitments through efforts at the HNRCA to increase our understanding of the relationships between nutrition and the well-known loss of physiological function that occurs with aging; and relationships between diet and the onset of diet-related disorders.

It is our aim, in cooperation with Tufts University, to provide the research base that will be used to design diets that provide appropriate amounts and forms of nutrients for our adult population so that people will be better able to achieve their full genetic potential.

T. B. Kinney, Jr.
Administrator
Agricultural Research Service

The USDA Human Nutrition Research Center on Aging at Tufts University is one of five research centers created by Congress to study the effect of human nutrition on health.

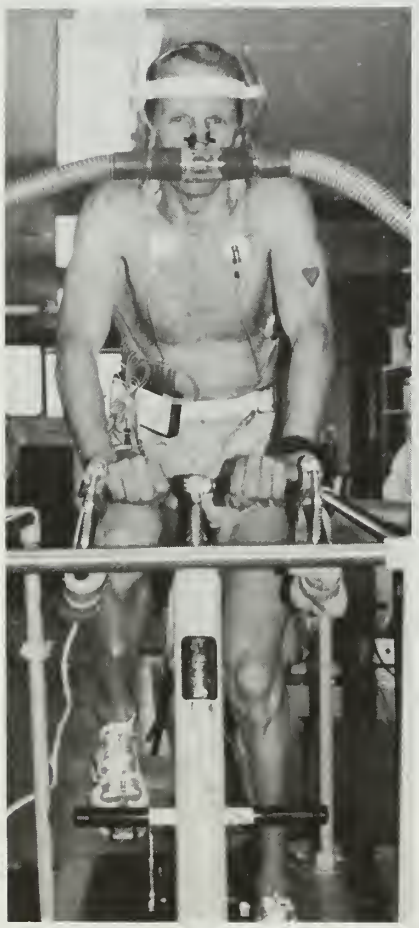
Established in 1982, and situated in downtown Boston on the Tufts health sciences campus, the center is the site of the most advanced research in the world on human nutrition and aging.

It is housed in a fifteen-story building that is a combination of laboratories, offices, and modern hotel-type accommodations.

The center has the capacity to conduct research at all levels—from cellular research, to animal and human studies, to population studies.

At the Human Nutrition Research Center on Aging more than 2,000 people each year are evaluated for admission to studies. For the first time, senior citizens are participating in research that will affect their generation and provide preventative measures for future generations.

Results from these studies enable scientists to make recommendations that will improve the quality of life for our elderly citizens and the general health of the American public.



Above: Research volunteer participates in exercise test to determine aerobic fitness

Top left: Solar-heated rooftop pool for volunteer exercise

Top right: Spacious, fully equipped recreation room for volunteers living at the center

Social and Economic Importance

As a regional center for excellence in nutrition research, the center and its accomplishments, over the next several decades, promise to be a major factor in fostering public health in this country.

Today, for the first time in history, there are as many Americans sixty-five years of age or older as there are teenagers.

In 1900, one of twenty-five Americans was over sixty-five years of age. By 1987, this number increased to one of nine, 11 percent of the total population. By the year 2050, statisticians project that one of every five Americans, 20 percent of the total population, will be over sixty-five.

In 1986, the life expectancy for women was 78.3 years and 70.7 years for men and the numbers in 2050 are projected to be 81 years for females and 73.6 years for males.

According to medical economists, it is important to keep this population healthy and functioning independently as long as possible to control health-care expenses.

Mission and Accomplishments

Aging is a physical process and one of gradually diminished functioning. Some people age "well" and enjoy vitality and good health. Others must cope with health conditions that interfere with the full enjoyment of life.

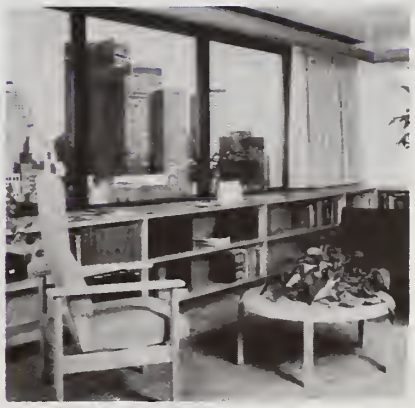
Osteoporosis, cataracts, arteriosclerosis, decreased function of the immune system, and loss of physical capacity are some of the debilitating conditions associated with the aging process.

Nutritional scientists agree that how and what an individual eats has a considerable effect on the length and quality of life. Poor nutritional practices may contribute to the development of diseases such as diabetes, cardiovascular disease, osteoporosis, and certain types of cancer.

Consequently, scientists at the Human Nutrition Research Center on Aging are exploring how diet alone and in association with other genetic, physiological, sociological, and environmental factors can delay or prevent the onset of degenerative conditions associated with aging.

Left: Research volunteer meticulously consumes all particles of food while on a metabolic study

Center: Dining room in the Metabolic Research Unit



Above: Library for resident research volunteers

To accomplish this mission, the following objectives have been outlined:

to determine how nutritional factors influence the progressive loss of tissue function resulting in degenerative conditions associated with the aging process;

to determine the nutrient requirements necessary to obtain optimal, functional well-being for a maturing population and how changes in energy metabolism and nutrient utilization influence these requirements; and

to develop methods to investigate the nutrient needs of the elderly.

The center's research findings are contributing to new recommendations for dietary allowances in the maturing and elderly population. It is hoped the results will enhance the quality of life and reduce health-care costs by delaying age-related degenerative conditions.

Over the past five years researchers have discovered several important relationships between nutrition and aging. These accomplishments include:

demonstrating that vitamin C intake is positively related to high blood levels of high density lipoproteins—protein and fat compounds that are associated with reduced risk of cardiovascular disease;

identifying, fat, protein, and gene markers in the blood that predict early heart disease and may be used to recommend diet therapy for high-risk individuals;

noting a hormonal form of vitamin D that can influence skin aging and affect conditions such as psoriasis;

finding that the ability of skin to synthesize vitamin D from sunlight decreases markedly with age, supporting the need to increase the dietary requirement for this vitamin;

Meal preparation in the Metabolic kitchen

showing that the decreased ability to produce stomach acid occurs in 20 percent of the elderly population and interferes with the absorption of several vitamins and minerals;

discovering that elderly women ingesting low levels of calcium lose mineral from the spine at a significantly greater rate than those whose intakes exceed the Recommended Dietary Allowances (RDA);

observing that calcium supplements, when taken with a meal, impair iron absorption from that meal;

showing that under experimental conditions vitamin E plays an important role in the immune system and may act to reverse age-related declines in immune responses;

uncovering the dietary relationship between the delay of cataract or cataract-like changes to the eye lens by using caloric restriction and compounds that bind with oxygen, such as vitamin C;

developing a culture system for normal human pigment cells that has allowed rigorous studies of the tanning response and has provided the first evidence that vitamins A and D may be involved in this important sun protective function of human skin; and

finding evidence that B_6 requirements are increased in the elderly and that vitamin A requirements may be reduced in this population.

Center Organization

With nearly fifty research scientists and a staff of two hundred, the Human Nutrition Research Center on Aging is organized around five units: Metabolic Research Unit, Nutrition Evaluation Laboratory, Comparative Biology and Medicine, Scientific Computing and Biostatistics, and Building Administration. Their efforts are directed toward supporting and facilitating the center's research. Eleven laboratories are organized in such a way as to focus on the relationship of nutrition to the function of major body systems.

A Unique Facility

The USDA Human Nutrition Research Center on Aging, consisting of fifteen stories with 200,000 square feet of space, contains a Metabolic Research Unit devoted to human nutrition and aging. Comfortable living quarters and recreational areas are provided for research volunteers, many of whom live in the center for months at a time while participating in long-term dietary studies. Meals are prepared in a specialized kitchen and served in an attractive dining room.

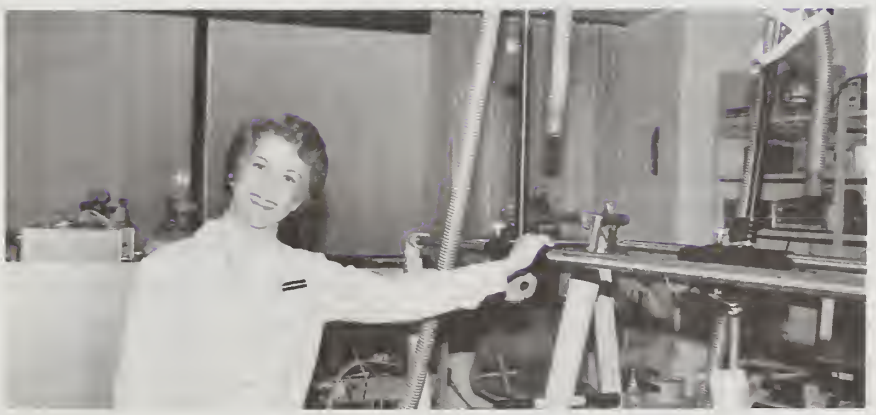
Extensive laboratories adaptable for biochemical, physiological, pathological, and behavioral studies support both human investigations and relevant experimental animal research.

The center is equipped with sophisticated instrumentation including a neutron activation facility and a whole-body gamma counter to assess body composition. Each laboratory has access through terminals to a central computer facility.

A whole body counter provides a means for the noninvasive measurement of body composition and the retention of gamma-emitting substances metabolized by human and animal subjects and tissue. Presently, methodologies are in place for measuring calcium-47, iron-59, and zinc-65. Methods to measure potassium-40, the most accurate indicator of lean body mass, are under development.

In addition, a gas chromatograph and isotope ratio mass spectrophotometer are used to analyze nutrient utilization, absorption, and retention; determine and quantify the optimal level of energy intake; and measure minute quantities of essential biological molecules such as amino acids and vitamin metabolites.

Such technology enables the scientists to conduct a major research program in the absorption, utilization, and excretion of nutrients in maturing and elderly populations, establishing the center as the international leader in assessing the nutrient bioavailability among the elderly.



Top: Joseph Kehayias, Ph.D., scientist whose primary interest is the analysis of body composition, with research volunteer

Bottom: Carol Meredith, Ph.D., displays treadmill and cycle ergometer used for testing volunteers' exercise capacity

Four Support Service Programs

Metabolic Research Unit

Robert M. Russell, M.D., Director, Human Studies
Judith Frazier, B.A., R.N., Manager

The Metabolic Research Unit (MRU) supports center research by recruiting, screening, and admitting healthy volunteers to participate in research studies. Over four thousand inquiries from the general public are made annually in response to recruitment activities. Over two thousand applicants are evaluated annually for admission to studies.

Included in the MRU space are medical examination rooms, a medical records library, swimming pool, sauna, and other recreational areas. The kitchen is designed and equipped to support metabolic research studies requiring precise nutrient control. Research is supported by a staff of nurses, recruiters, and dietitians; and other services such as medical records, social work, recreation therapy, and food service. Twenty-four-hour medical coverage is provided by physicians for resident volunteers.

Various activities are utilized by the recruiters to promote center research to the general public. The Department of Nursing, available twenty-four hours per day, is responsible for implementing research projects. Dietitians and paraprofessionals in the Nutrition Services Department are responsible for the interpretation, implementation, and successful outcome of the dietary research.

Nutrition Evaluation Laboratory

Frank D. Morrow, Ph.D., Manager

The Nutrition Evaluation Laboratory provides clinical and specialized biochemical analyses for human and animal research studies. The laboratory is organized into three functional units:

The Specimen Processing Unit (SPU) is responsible for receipt, processing, storage, and workload tracking of blood, urine, and fecal samples;

The Clinical Core Unit (CCU), a licensed diagnostic laboratory, provides clinical results for approximately thirty different procedures related to hematology, blood chemistries, and urinalysis; and

The Specialized Procedures Unit (SPU) provides approximately sixty laboratory services, including analyses of such nutrients as vitamins A, B_1, B_2, B_6, C, and D, and trace metals such as selenium, zinc, and copper.

Laboratory assay results can be presented to investigators in a variety of hard-copy report formats or by direct electronic transfer.

Comparative Biology and Medicine

Donald Smith, M.Sc., R.L.A.T., Manager

Comparative Biology and Medicine (CB&M) provides a centralized animal-care program that exceeds all federal, state, and local guidelines and regulations, and is accredited by the American Association for Accreditation Laboratory Animal Care. Complete animal-care and maintenance programs are provided and a wide range of animal-technologist support services are available.

CB&M maintains species-specific, environmentally controlled animal rooms and a specialized animal diet kitchen. Daily observation of animals is performed by trained technicians. Clinical diagnostic veterinary services are provided on a daily basis by board-certified veterinarians. Animal quarters are monitored monthly by a sentinel-based viral, bacterial, parasite, and *Mycoplasma* health program. Animals are separated by species, vendor, and project.

Scientific Computing and Biostatistics

Saul Tannenbaum, M.S., Manager
Gerard Dallal, Ph.D., Biostatistician

Scientific Computing and Biostatistics maintain a central computing facility, and offer continuing education to help each researcher become self-sufficient in the use of the computer. For tasks beyond the capabilities of the units, the divisions provide customized systems, programming support, and data entry services. The center's biostatisticians work to insure that investigators have access to the analytical tools necessary for their research.

Opposite page, left: Judith Frazier, R.N., manager of the Metabolic Research Unit, confers with head nurse Leah Zanotti, R.N.

Opposite page, right: Frank Morrow, Ph.D., manager of the Nutrition Evaluation Laboratory, adjusts the centrifugal analyzer for blood analysis in the Clinical Core Unit

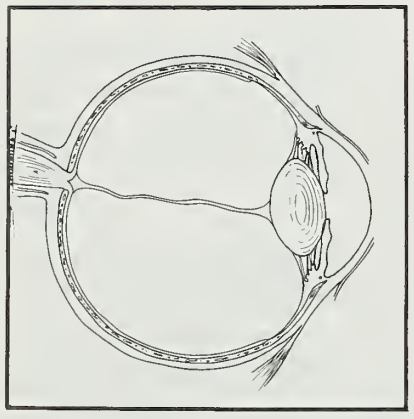
This page, left: Don Smith, M.Sc., manager of Comparative Biology and Medicine, reviews a tissue sample photograph produced by the Scanning Electron Microscope

This page, right: Saul Tannenbaum, M.S., manager of Scientific Computing, and Gerard Dallal, Ph.D., are available to assist HNRCA staff.

Scientific Laboratories

The Human Nutrition Research Center on Aging is the site for eleven laboratories organized to address the functions of human body systems. To complement these efforts, the Program in Epidemiology examines the nutritional status of populations of varying ages, ethnicity, and socioeconomic backgrounds.

Eye



Nutrition and Cataract Research Laboratory

Laboratory Chief: Allen Taylor, Ph.D.
Scientists: Joseph Berger, Ph.D.; Ruth Lipman, Ph.D.; Kathleen Killick, Ph.D.; Jessica Jahngen, M.S.

Cataracts, a condition in which the lens of the eye becomes opaque and causes partial or total blindness, is found in fifty million elderly people throughout the world. It has been estimated that to delay the onset of cataract formation by only ten years would eliminate half of the 700,000 cataract extractions performed annually in the United States, saving $1.5 billion per year.

The objective of the Nutrition Cataract Research Laboratory is to determine how improved nutrition early in life might delay lens opacification. The laboratory pursues this mission principally by using human and other mammalian lens tissues, animals, whole lenses, and cultured lens epithelial cells. Confirmation of the data obtained in laboratory tests is accomplished using epidemiological and clinical studies on human populations.

Since the lens is primarily composed of protein, a significant effort is being made to understand the regulation of lens-protein metabolism.

Muscular System

Research volunteer undergoing hydrostatic weighing

Physiology Laboratory

Laboratory Chief: William J. Evans, Ph.D.
Scientists: Carol N. Meredith, Ph.D.; Maria A. Fiaterone, M.D.; Vernon R. Young, Ph.D.; Susan Roberts, Ph.D.

The effects of age on the body's response to increased physical activity are largely unknown. The Physiology Laboratory focuses on the effects of age and physical activity on the metabolism of protein, glucose, and calcium, and their relationships to body composition.

The laboratory makes use of stable isotopes, balance techniques, and glucose/insulin infusion techniques to establish how energy expenditure, body composition, and the turnover of nitrogen and glucose vary in healthy persons in response to age and different types and intensities of physical activity.

Studies from this laboratory have demonstrated that increased aerobic activity in previously sedentary elderly can increase aerobic capacity. In addition, strength training in previously sedentary elderly men is associated with a large improvement in strength and increased muscle size. Another important finding is that the protein requirements of middle-aged and young endurance-trained men are greater than the current recommendations.

Digestive System

Gastrointestinal Nutrition Laboratory

Laboratory Chief: Robert M. Russell, M.D.
Scientists: Judy Ribaya-Mercado, D.Sc.; Stanley N. Gershoff, Ph.D.; Joseph Tecce, Ph.D.

In the Gastrointestinal Nutrition Laboratory, scientists use human volunteers and animal models to determine how aging and associated factors such as medication use affect the absorption and metabolism of nutrients. Results will help determine if changes in the Recommended Dietary Allowances (RDA) for vitamins and minerals for the elderly are warranted.

Researchers have identified the increased prevalence of atrophic gastritis in the elderly, and have examined the effect of this condition on the absorption of certain vitamins. For example, in atrophic gastritis, preliminary studies show that vitamin B_{12} malabsorption is caused by an overgrowth of bacteria, which deprive the human host of this nutrient.

Tests on the effects of acid-lowering and acid-neutralizing drugs on the vitamin folic acid have shown that both antacids and histamine receptor blocking agents (used to treat peptic ulcers) significantly inhibit absorption of folate.

Scientists have also developed new methods to measure vitamin B_6 metabolism and vitamin A absorption. Results to date show that vitamin A absorption may increase with age, thus providing evidence that a lower RDA for vitamin A may be indicated for the elderly.

Drs. Russell and Rosenberg prepare a research volunteer for insertion of a gastric tube used to measure the acidity of the stomach and intestine

Nutrient Bioavailability Laboratory

Director: Irwin H. Rosenberg, M.D.
Laboratory Chiefs: Jacob Selhub, Ph.D.; Richard J. Wood, Ph.D.
Scientist: Joel Mason, M.D.

Vitamin and mineral deficiency in the elderly may not be solely due to low dietary intakes, but may be influenced by factors that affect vitamin and mineral absorption and utilization (bioavailability).

In the Nutrient Bioavailability Laboratory, scientists examine the biochemical basis for the absorption, utilization, and excretion of nutrients. In addition, scientists are investigating the interactions between foods and drugs commonly used in the maturing and elderly populations. Research is focused on the mechanisms of absorption and excretion of water-soluble vitamins and on the effects of diet on mineral balance and metabolism.

Vitamin K Nutrition Laboratory

Laboratory Chief: James A. Sadowski, Ph.D.
Scientist: Guylaine Ferland, Ph.D.

Vitamin K, a fat-soluble vitamin, is essential for the synthesis of proteins involved in blood clotting. The elderly may require higher levels of vitamin K due to a decreased rate of absorption. Use of antibiotics, which suppress the normal bacterial synthesis of the vitamin in the gut, may further increase these needs.

Scientists are developing methods for the biochemical and functional assessment of vitamin K status in humans, and seek to determine the nutritional sources, bioavailability, and requirements in aging human and animal populations. The laboratory also is looking at changes that occur in the metabolism and function of vitamin K with aging and their impact upon clinical and nutritional status. Another goal is to identify, isolate, purify, and characterize the enzymes involved in vitamin K metabolism.

Dr. Munro and assistant in the Nutrition and Cell Programming Laboratory

Endocrine System

Nutrition and Cell Programming Laboratory

Laboratory Chief: Hamish N. Munro, M.D., D.Sc.

To better identify optimal nutrient intakes at different stages of life, particularly the later years, new criteria based on bio-regulatory mechanisms for judging dietary adequacy are sought.

The Nutrient and Cell Programming Laboratory is assessing the adequacy of protein and energy intake, and examining the impact of aging on the capacity of an iron-phosphorus-protein complex, intracellular ferritin, to protect aging cells and tissues against iron toxicity.

Using new techniques for studying protein and energy metabolism, researchers have shown that protein and energy intakes affect the levels of plasma somatomedins, amino acid compounds which mediate the effect of growth hormone. These techniques have been used to evaluate nutritional status in pregnancy and the effects of malnutrition in infancy.

The laboratory is developing techniques for investigating the aging genome (chromosome sets) to study the long-term dietary effects on nutrient-sensitive control mechanisms of cells and tissues during the aging process.

Immune System

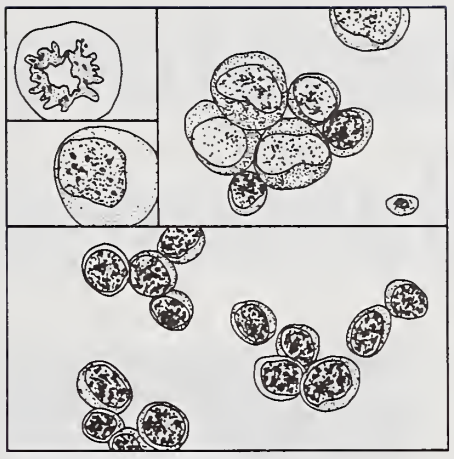
Nutritional Immunology and Toxicology Laboratory

Laboratory Chief: Jeffrey B. Blumberg, Ph.D., F.A.C.N.
Scientists: Mohsen Meydani, D.V.M., Ph.D.; Simin Nibkin Meydani, D.V.M., Ph.D.; Ganesa Yogeeswaran, Ph.D.

Aging is associated with a decline in the immune response to viruses, bacteria, and other foreign agents. Aging is also characterized by the formation of free radicals and lipid peroxidation products that may contribute to the decline of immune function.

In the Nutritional Immunology and Toxicology Laboratory, scientists explore the interactions of nutrients such as vitamins A, C, and E, selenium, iron, and dietary fat, with the immune system and lipid peroxidation events. Research approaches in the laboratory utilize human volunteers, animal models, and cell culture systems. Results from these studies are helping to determine whether guidelines for these nutrients are adequate for maintaining optimal function.

Discoveries in animal models have revealed that vitamin E levels in certain brain regions decrease with age such that



elevated dietary intakes of this vitamin are necessary for the maintenance of steady-state concentrations. Increased formation of the hormone-like prostaglandin E_2, a metabolite of the fatty acid arachidonic acid, and a decrease in vitamin E and glutathione antioxidant defense systems appear to contribute to the decline of immune function in old animals. Findings suggest an increased requirement for vitamin E and/or other dietary antioxidants during the aging process.

Skin

Cutaneous Gerontology Laboratory

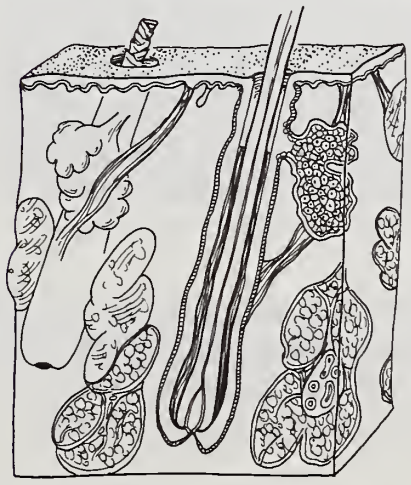
Laboratory Chief: Barbara A. Gilchrest, M.D.
Scientists: Philip Gordon, Ph.D.; Mina Yaar, M.D.; Monica Peacocke, M.D.

Aging of the human body is the result of complex changes in individual cells. This process can be conveniently studied in the skin, the body's largest organ and one with many well-recognized age-associated changes in appearance and function.

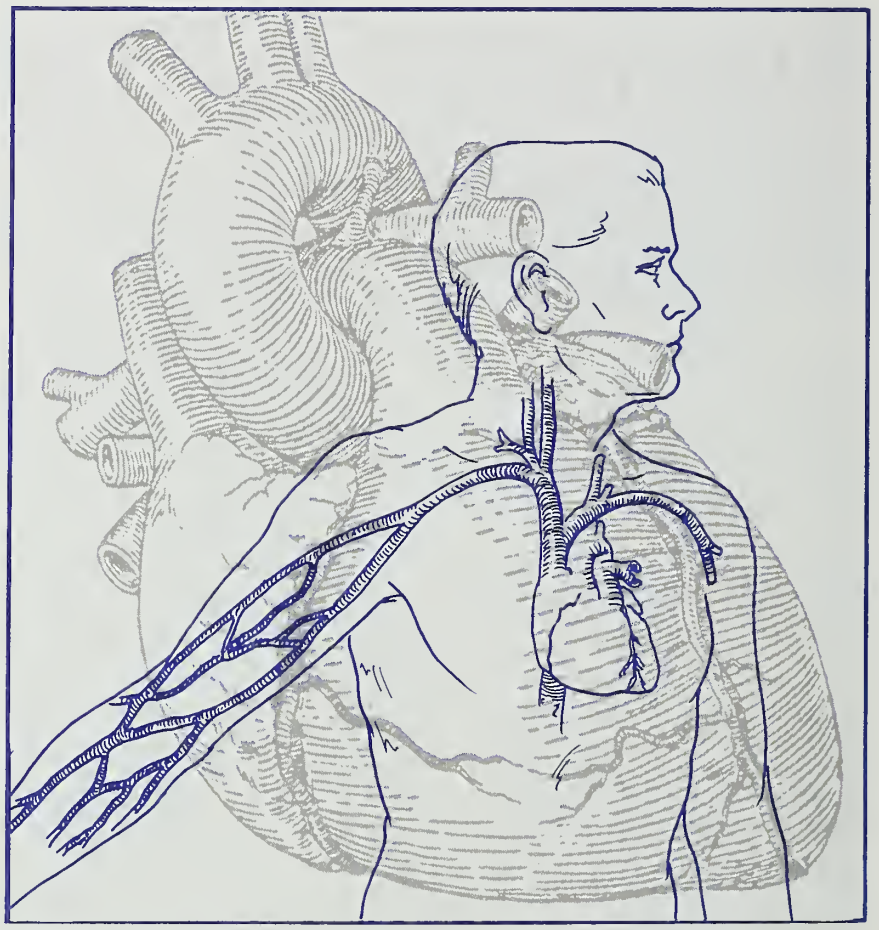
To date, most nutrition studies have concerned either human subjects or laboratory animals. Recent advances in cell culture technology make possible studies of individual cell types in a precisely determined nutrient environment, as a complement to conventional studies.

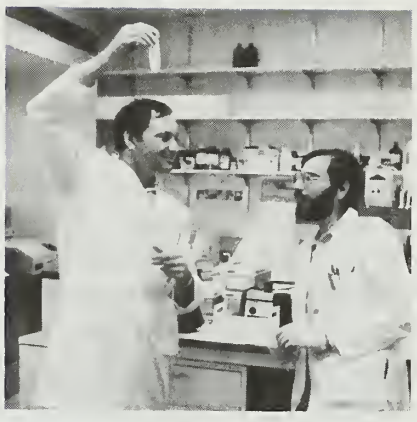
The Cutaneous Gerontology Laboratory studies cultures of human-skin-derived cells from healthy young and old donors to better understand the cutaneous aging process and the impact of nutritional intake or other potentially modifiable environmental factors. A further goal is to devise dietary or other strategies to mitigate against the unwanted age-associated changes in skin appearance and function, in order to maximize the psychologic and physiologic fitness of the elderly.

Research regarding the interaction of aging and nutrition in the skin may prove helpful in the prevention or treatment of skin cancer, chronic skin ulcers, and even vitamin D deficiency and associated bone fractures. These combined health problems presently account for more than $10 billion annually in medical expenses.



Heart and Circulatory Systems





Research scientists in the Lipid Metabolism Laboratory

Cardiovascular Research Laboratory

Laboratory Chief: Peter Libby, M.D.
Scientists: Stephen Warner, M.D., Ph.D.; Robert Salomon, M.D.

Though mortality rates from cardiovascular disease have been declining in recent years, heart disease remains the number one killer in the United States. In 1986 an estimated 1.5 million Americans suffered myocardial infarctions. Half of these individuals were under the age of sixty-five, and 550,000 died as a result of these heart attacks. In 1986, heart disease accounted for more than $78 billion among expenditures associated with cardiovascular diseases.

Investigators in the Cardiovascular Research Laboratory study the interactions of cardiovascular cells with nutrients and factors influenced by diet, focusing on vascular degenerative processes such as arteriosclerosis and hypertension.

By understanding the functional capabilities of the cells of the blood vessels in relation to degenerative processes, scientists plan to define the cellular metabolic responses and environmental factors such as diet, which may trigger various responses.

Accomplishments of the laboratory include the development of a serum-free medium that enables scientists to examine protein accumulation and degradation, as well as nutritional requirements of growing arterial smooth muscle cells.

Lipid Metabolism Laboratory

Laboratory Chief: Ernst Schaefer, M.D.
Scientists: Jose Ordovas, Ph.D.; Jeffrey Cohn, Ph.D.; Jacques Genest, M.D.; Stefania Fava, M.D.

Interest in lipoproteins, protein and fat compounds found in the blood, arose in the 1950s, when it was suggested that elevated concentrations of cholesterol were associated with vascular disorders, primarily ischemic heart and coronary heart disease.

In their studies of the progression of cardiovascular disease, scientists in the Lipid Metabolism Laboratory are examining the relationships between lipoprotein metabolism, nutrition, and aging to determine what alterations in life-style may reduce cardiovascular risk factors and atherosclerosis.

Investigators are in the process of identifying biochemical and gene abnormalities that allow for precise identification of individuals at high risk for developing premature coronary artery disease. The short- and long-term dietary regulations of plasma lipoprotein in both young and elderly adults are also being investigated.

Particular emphasis is placed on defining optimal dietary intakes of cholesterol and fat to minimize biochemical abnormalities associated with an increased risk of premature coronary artery disease, and to provide an adequate dietary intake of essential fatty acids.

Calcium and Bone Metabolism Laboratory

Laboratory Chief: Bess Dawson-Hughes, M.D.

Osteoporosis, a degenerative disease found in both men and women over fifty, is a condition in which bone loss is accelerated and bone density is much lower than expected for an individual's age. Occurring more rapidly in women, the reduction may reach 40 percent of total bone mass.

Bone loss in women increases after menopause due to decreased estrogen levels in the blood. One-third of the female population over sixty years of age can anticipate becoming victim of fractures of the spine. Osteoporotic bones break more easily than normal bones, and in advanced osteoporosis, minor injuries may lead to bone fractures.

Approximately 1.2 million of such fractures occur annually in the United States, and severe fractures are fatal in 12 to 20 percent of these cases. Fifty percent of the survivors require long-term nursing-home care.

Although calcium and osteoporosis have been the subject of much investigation, conclusions about the relationship between calcium intake and bone loss have not been established.

To define this relationship in healthy postmenopausal women, a five-year double-blind, placebo-controlled calcium intervention field trial is currently underway in the Calcium and Bone Metabolism Laboratory. One goal is to determine the short- and long-term effects of increased calcium intake. Data from a pilot study indicate that women with a low dietary calcium intake appear most likely to benefit from increased calcium intake.

In addition to the field trial, the laboratory is examining calcium absorption, as well as identifying foods that hasten or interfere with the mineral absorption. Emphasis is placed on defining the calcium intake requirement of healthy postmenopausal women.

Bone scan used to measure bone density

Data from epidemiological studies is collected in the natural environment

Program in Nutritional Epidemiology

Scientists: Paul Jacques, D.Sc.; Johanna Dwyer, D.Sc., R.D.; William H. Dietz, Jr., M.D., Ph.D.
Project Manager: Constance Otradovec, M.A.

The Program in Nutritional Epidemiology is concerned with identifying factors affecting nutritional status and determining the influence of that status on health in human populations. Nutritional epidemiologic studies provide unique opportunities to examine nutritional status and its modifiers under actual human living conditions rather than under controlled experimental conditions. The Human Nutrition Research Center on Aging has completed two major epidemiological studies.

In the Nutritional Status Survey (NSS), a three-year study of approximately 1,000 free-living and institutionalized individuals sixty years of age and older, researchers obtained data on biochemical nutrient markers, diet, supplement intakes, medication usage, selected anthropometrics, demographics, and health factors.

The purpose of the Boston Cataract Study was to examine the nutritional status of 131 individuals with and without cataracts. Results indicated an increased risk of cataracts for subjects with low-blood levels of carotenoids, some of which are converted to vitamin A. Individuals with high intakes of vitamin C were also at lower risk of developing cataracts.

Population Studies

A Chronology of Milestones

Informal negotiations between Tufts University and the United States Department of Agriculture began in 1976 at the initiative of Jean Mayer, president of Tufts and one of the world's esteemed nutritionists.

In 1977 Congress directed the Secretary of Agriculture to establish a comprehensive human nutrition research program and to study the potential cost and value of regional research centers for nutrition. The Food and Agriculture Act of 1977 states in part: "Congress hereby finds that there is evidence of a relationship between nutrition and many of the leading causes of death in the U.S.; that improved nutrition is an integral component of preventative health care; that there is a serious need for research on the effects of diet on degenerative diseases and related disorders."

The Agriculture Appropriations Bill, passed July 1977, instructed the USDA to establish an "adult human nutrition research facility at Tufts University in Massachusetts," and provided planning funds for that facility.

By September 1977, facility and programmatic planning had been initiated by representatives of USDA, Tufts University, Harvard University, Massachusetts Institute of Technology, and other universities.

In 1978, Congress committed funds for construction and placed the center under the direction of the newly created Science and Education Administration of USDA. The conferees stipulated in their agreement that the center's programs complement those of the National Institutes of Health and be conducted in close collaboration with the National Institute on Aging.

On August 1, 1979, the Cooperative Agreement between Tufts University and the USDA was signed, and on October 23 of the same year, the National Institute on Aging and the USDA signed a Memorandum of Understanding detailing their mutual interest in the Human Nutrition Research Center on Aging at Tufts University.

Tufts University donated land from its Boston campus for the Human Nutrition Research Center on Aging.

Ground-breaking ceremonies took place on December 14, 1979.

Dr. Hamish N. Munro, a renowned nutrition scientist, was appointed as the first director and served until 1983. Under his leadership a scientific staff was recruited.

In 1982, initiatives to transform the administrative basis of the Human Nutrition Research Center on Aging led to plans for a government-owned contract-operated environment. Under this arrangement, Tufts operates the facilities and programs and the USDA, under the auspices of the Agricultural Research Service, acts as a contract monitor.

Under the USDA leadership and that of Tufts' president, Dr. Jean Mayer, the facility was opened in November 1982.

The Metabolic Research Unit, one of the most unique research facilities in the nation, admitted the first human research volunteers on July 5, 1983.

On April 15, 1988, the Human Nutrition Research Center staff celebrated the center's fifth anniversary.